

Dan is interested in the calibration of the HCAL for jets.

He defines “R” as the measured energy of a pion, probably in ADC counts

$$R = e E_e + h E_h$$

E_e is the fraction of the pion energy in the form of photons

E_h is the hadronic fraction

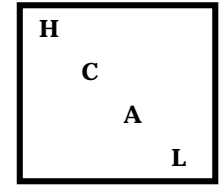
In most models, the fraction of the true energy in photons is

$$F_0 = E_e/E \sim 0.11[\ln(E)]$$

$$(1-F_0) = E_h/E$$

$$E = (eF_0 + h(1-F_0))/R$$

Dan’s goal is to estimate the constant h (or, equivalently, e/h) from test beam data, and then to identify individual pions in jets, use the distribution of the energy for each pion in the ECAL and HCAL to estimate its F_0 and use this to get a better resolution on its energy.



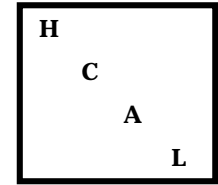
We want to related e and h to the constant that is commonly calculated

$E = R/e/(e/\pi)$ where

E is the true energy of the pion

e is a calibration constant tuned for electrons (ADC counts to energy)

e/π is another constant, which moves R/e to the correct true mean



If you do the algebra, you can get relations between e/π and h

$$e/\pi = e/h \cdot (1/(1+(e/h-1)F_0))$$

$$e/h = e/\pi \cdot (1-F_0)/(1-F_0 \cdot e/\pi)$$

Dan also points out that we have two different calorimeters

$$E = E_E + E_H$$

E_E is the part of the energy deposited in the ECAL

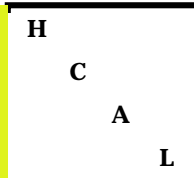
E_H is the part of the energy deposited in the HCAL

And that you thus need two e/π 's, one for ECAL and one for HCAL

For some strange reason, the HCAL NIM paper quotes e/h , instead of what they directly measure (e/π) (maybe to make it easy to compare to shower models. They quote $e/h=1.39$)



ECAL+HCAL



$$R = \text{response} = eE_e + hE_h$$

$$F_o = E_e / E \sim 0.11[\ln(E)]$$

$$E = R / e(e/\pi), e/\pi = e/h/[1 + (e/h - 1)F_o]$$

combined setup

$$E = E_E + E_H$$

Dan's version of my first two slides

$$E = 1/e_E(e/\pi)_E R_E + 1/e_H(e/\pi)_H R_H$$

ECAL/HCAL calib to electrons – e_E, e_H

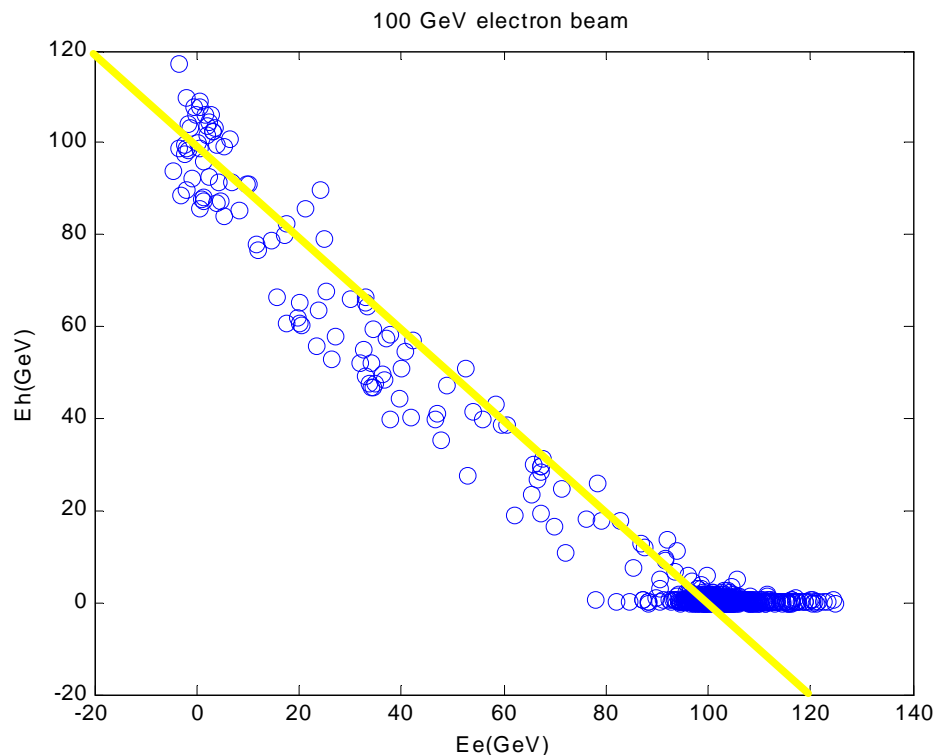
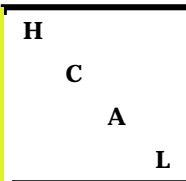
$(e/h)_H$ from mip in ECAL and $(e/\pi)_H$

$$(e/h) = (e/\pi)(1 - F_o)/[1 - F_o(e/\pi)]$$

$$(e/h)_H = 1.39 \text{ (NIM paper)}$$



e Beam Data - 100 GeV

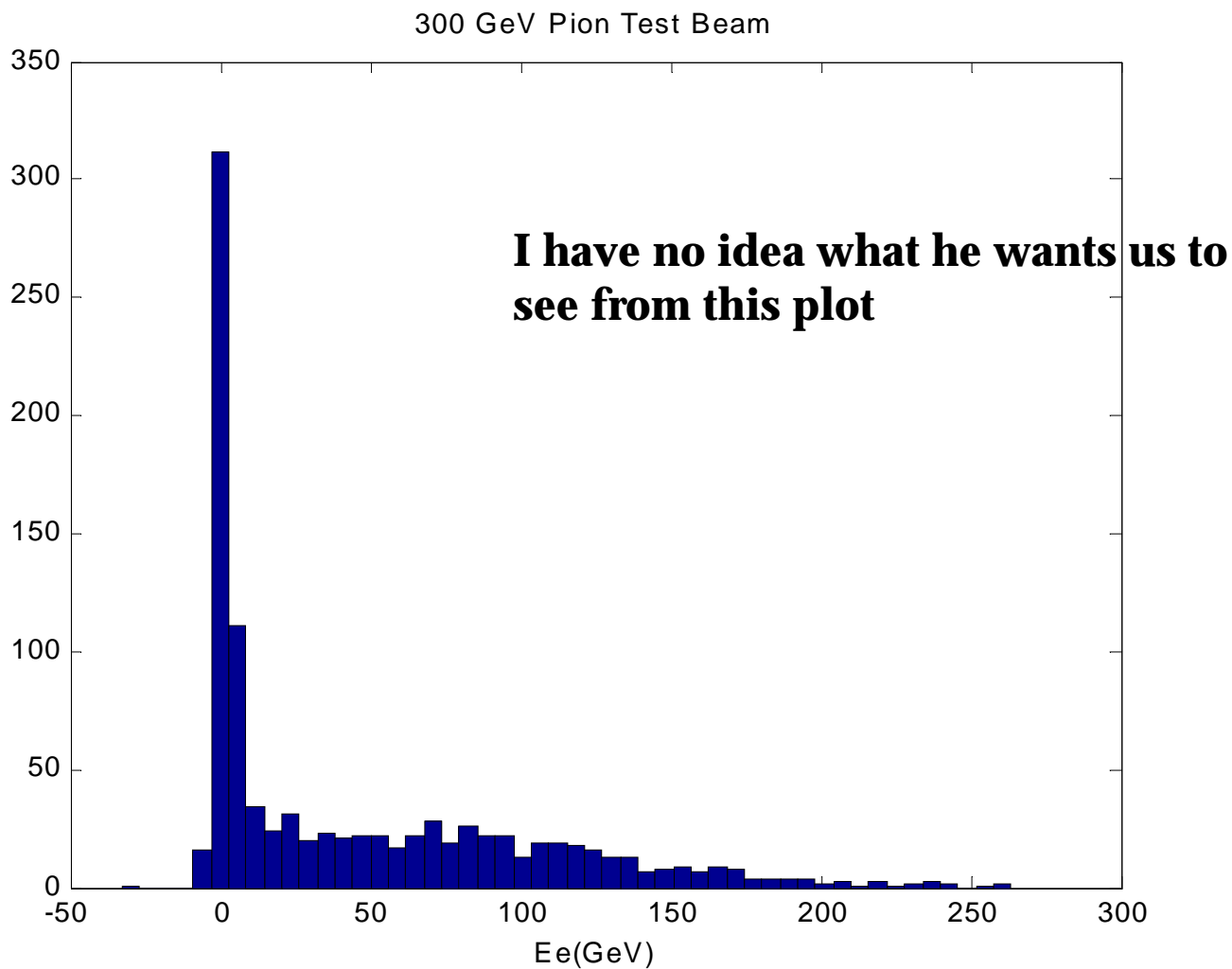
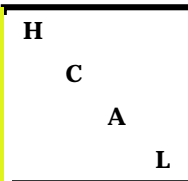


$e_E=0.94$ using only ECAL. For HCAL, norm is = 1 at 300 GeV --> with $e/h = 1.39$ that e/π should be 1.12. Thus $e_H = 1.12$. This fixes the 2 calibration constants.

I have no idea why he puts this plot here. However, the algebra converts $e/h=1.39$ to e/π for a 300 GeV particle.

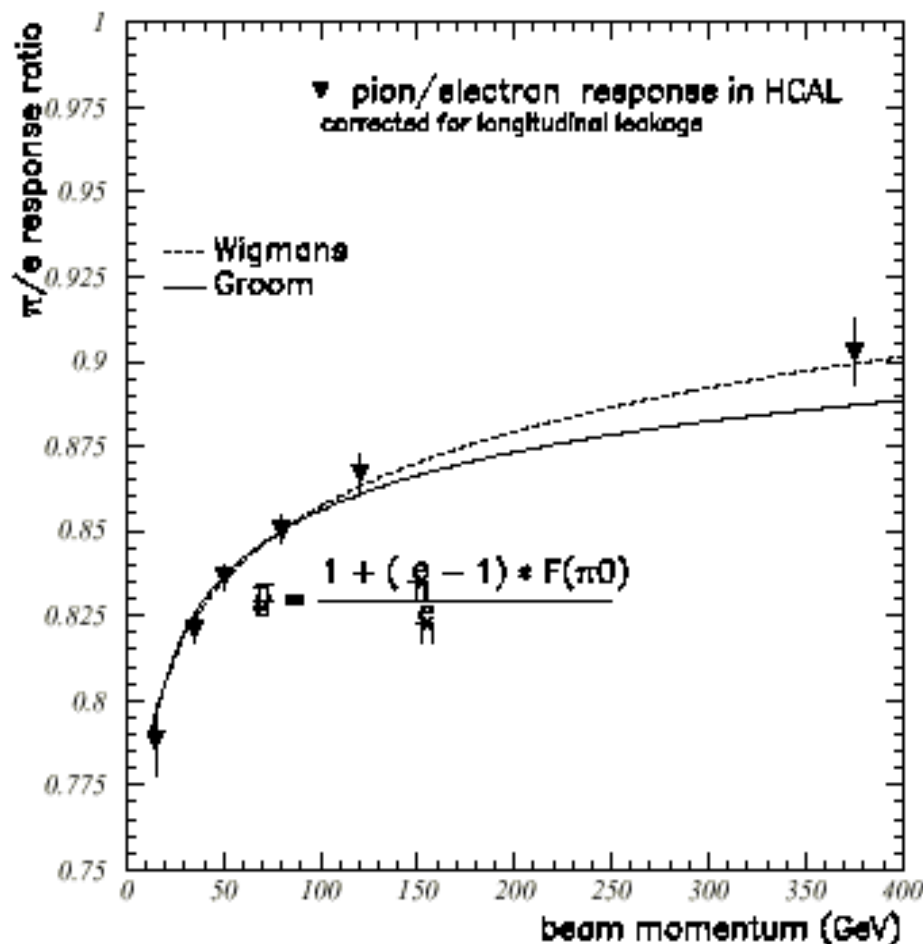
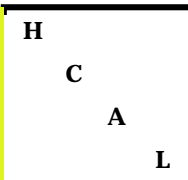


Measure e/h of HCAL





HCAL - e/h

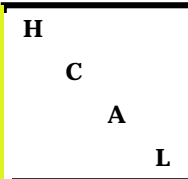


Use test beam data - ECAL linear and calibrated. HCAL for mip in ECAL yields e/h for HCAL of 1.39 (NIM paper) with Wigmans Fo of $0.11 \ln(E)$.

I think this shows how the NIM takes the measured $1/(e/\pi)$ and turns it into e/h. Note that at 300, π/e is around 0.875. $1/0.875$ is 1.14, in reasonable agreement with his calculation 2 slides back. This is what we'll need to do for the ECAL as well

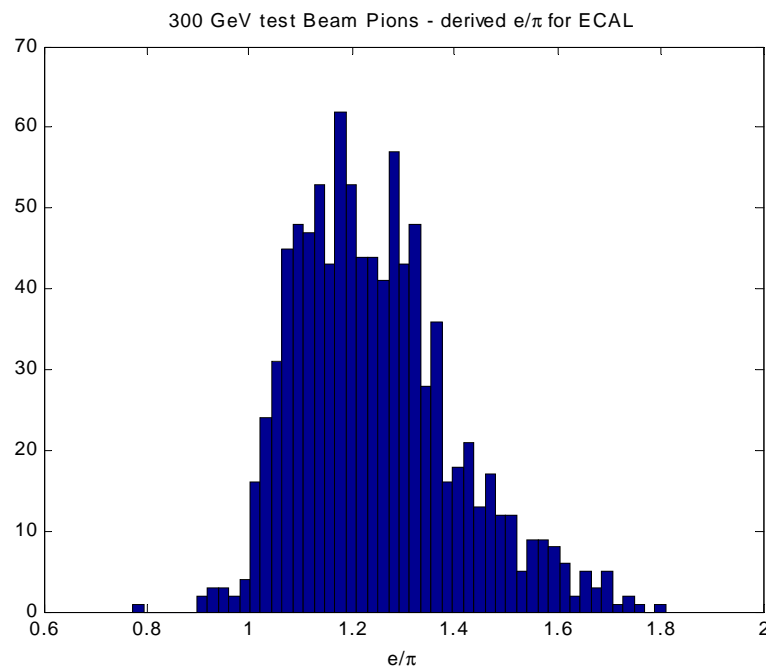


Measure e/h of ECAL?



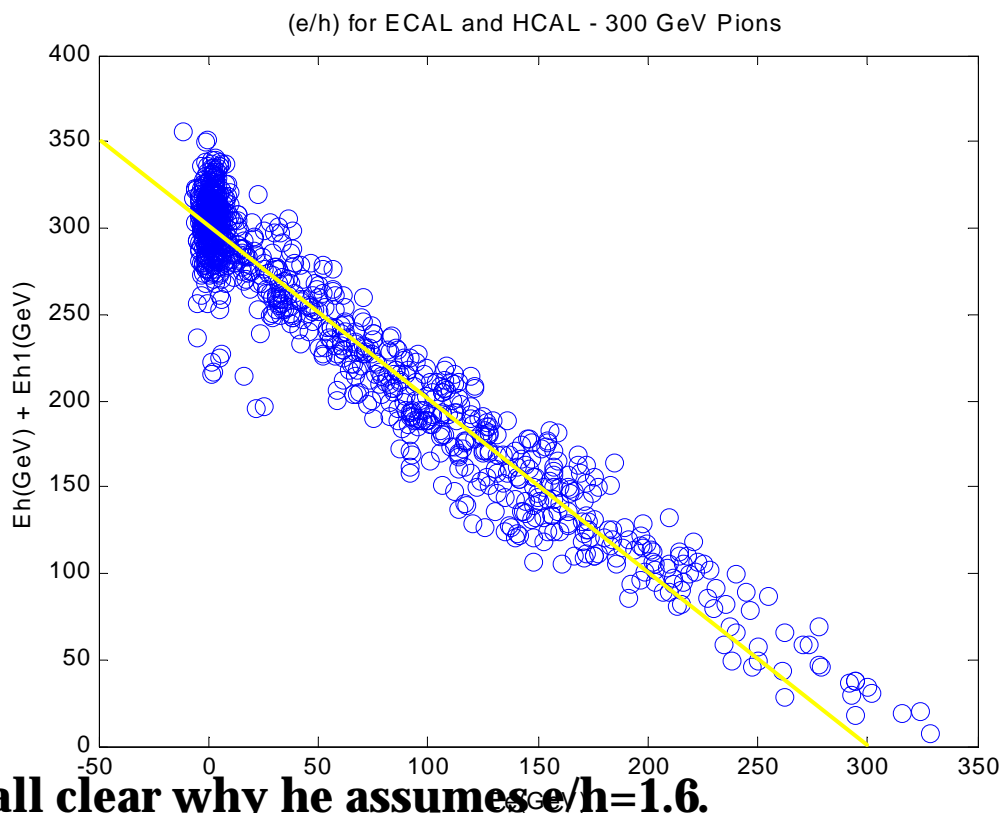
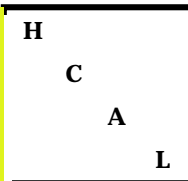
$$(e/\pi)_E = [E_{beam} - E_H] / (R_E / e_E)$$

To find e/h for ECAL, measure e/pi at different energies for showers where there is a substantial energy (> 30% of the beam energy) in ECAL. For the set of e/pi find e/h for ECAL. Assign e/h = 1.60 to ECAL.





e/h for ECAL and HCAL



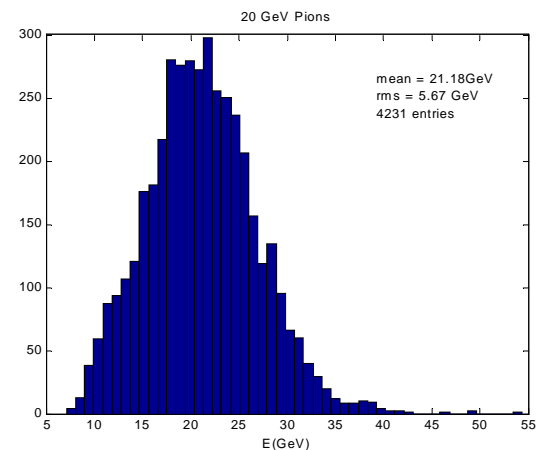
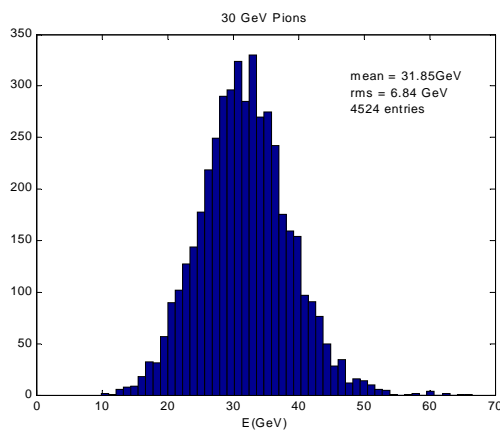
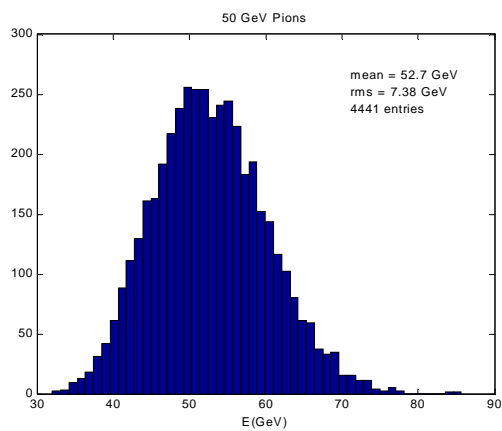
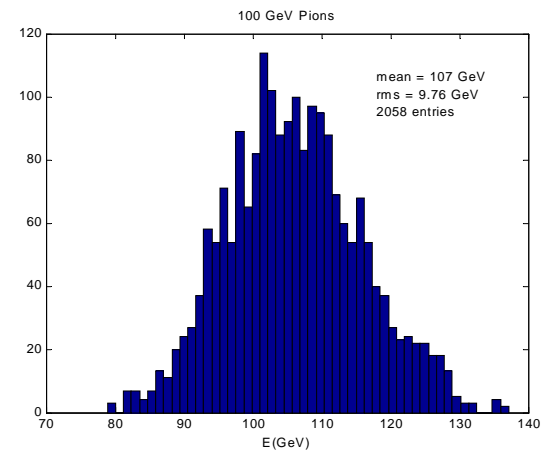
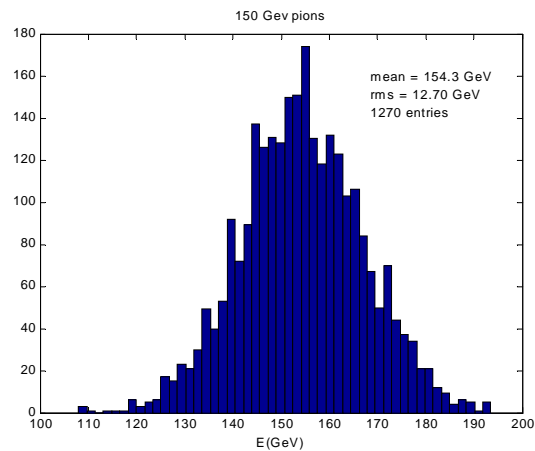
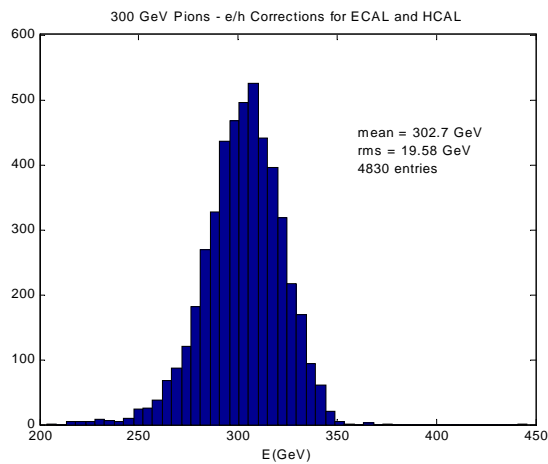
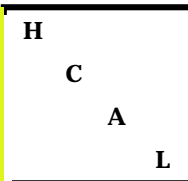
Not at all clear why he assumes $e/h=1.6$.

Somehow in jets, identify individual pions, and for them, use the fraction of the pion energy in ECAL to estimate f_0

Use $e/h = 1.6$ for ECAL, = 1.39 for HCAL and Wigmans for F_0 . Use energy seen in ECAL and HCAL to estimate F_0 and e/π event by event.



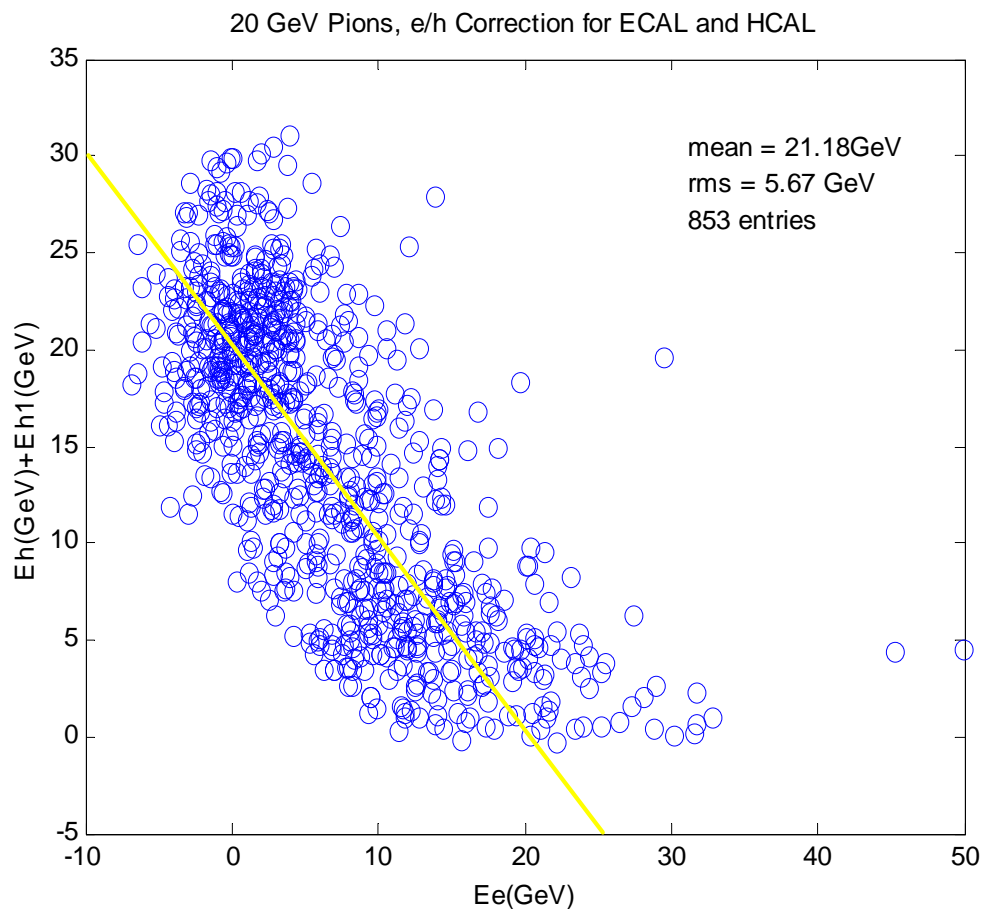
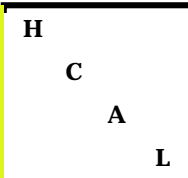
e/h for ECAL and HCAL



Raw resolutions, with out this new technique, for several pion energies?



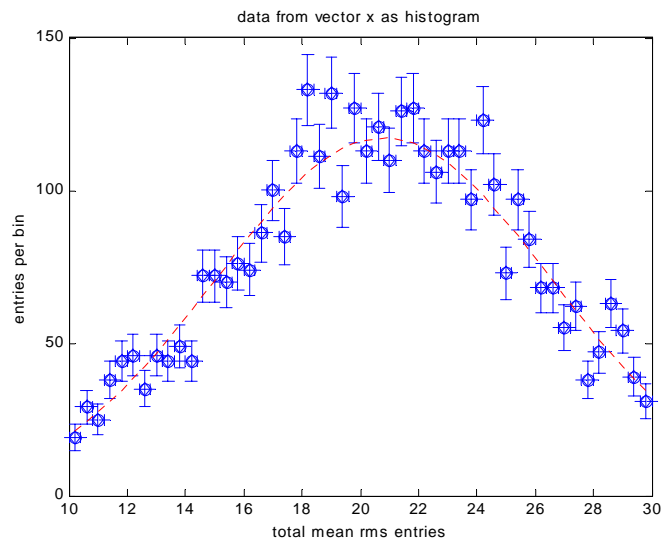
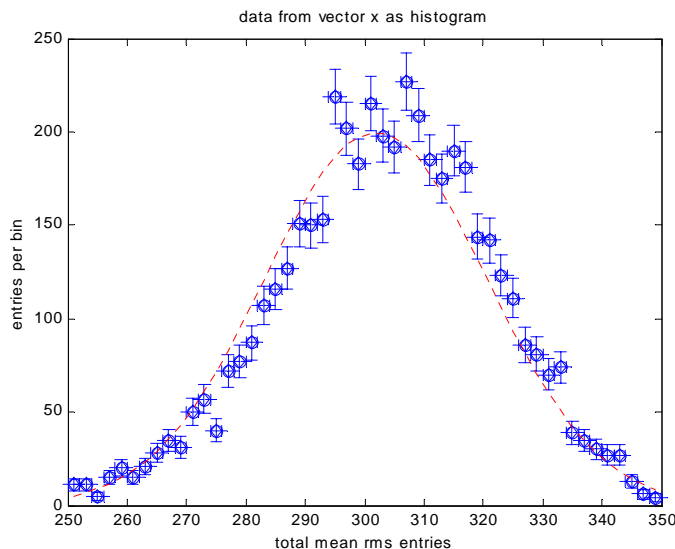
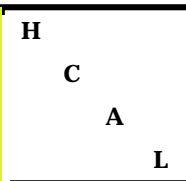
E/h for ECAL and HCAL



Shows how the energy is distributed between ECAL and HCAL. But, why is E_e negative?



Gaussian Fits

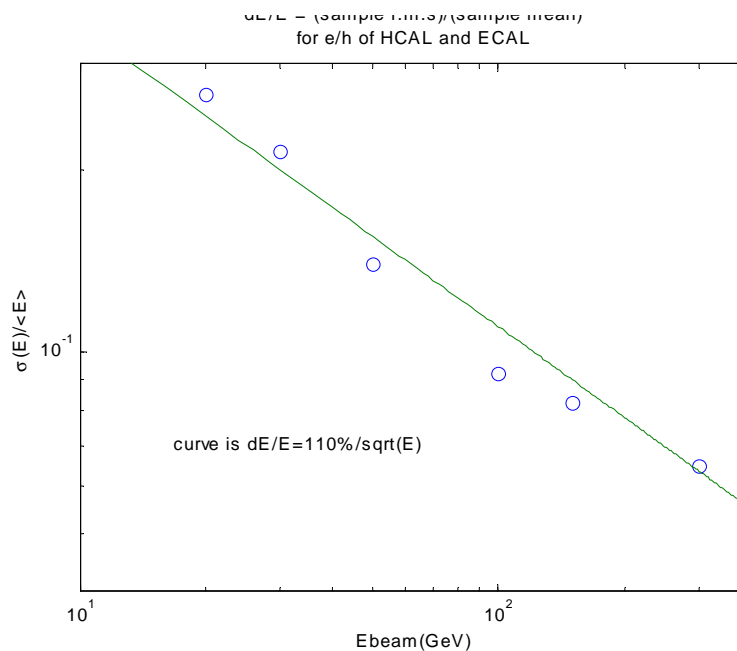
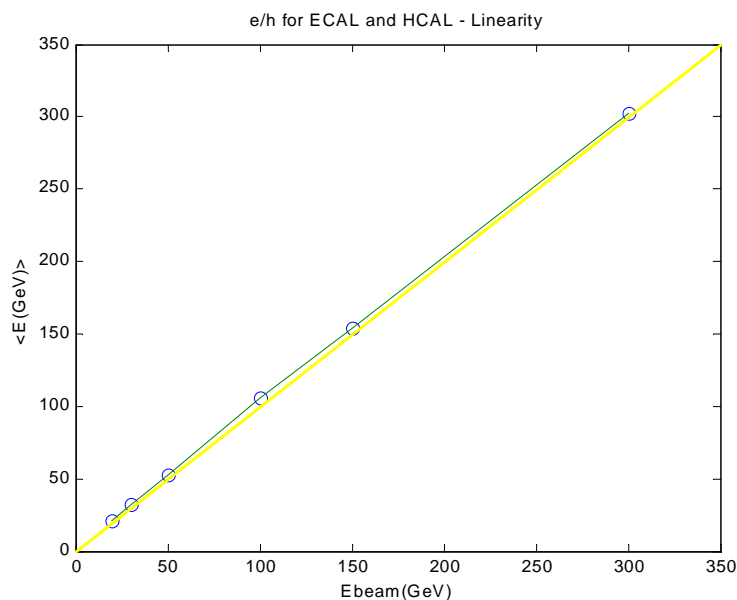
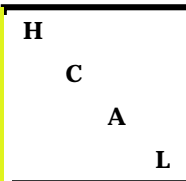


**I have no idea
what this
shows**

**Gaussian fits give the same results as
the sample mean and sample r.m.s.
Chisq/DOF is ~ 1 . Examples for 300
GeV and 20 GeV are shown.**



Linearity and Resolution



Linearity is restored to a few %. The resolution is Gaussian to a high level of accuracy with ~ NO constant term and a 110% stochastic coefficient